540496

Mechanical Dewatering Bench-Scale Testing Report

PREPARED FOR:	Mark Austin, U.S. Environmental Protection Agency Ed Barth, U.S. Environmental Protection Agency
COPY TO:	Russ Downey, Pfizer Inc. Vince D'Aco, Quantum Management Group, Inc.
PREPARED BY:	O'Brien & Gere Engineers, Inc.
DATE:	May 31, 2016

BACKGROUND

As part of the focused feasibility study (FFS) for Operable Unit 8 (OU8) (i.e. Impoundments 1 and 2) at the American Cyanamid Superfund Site in Bridgewater, New Jersey (Site), a bench-scale study was performed on behalf of Wyeth Holdings LLC between January 2016 and March 2016 to evaluate the feasibility of mechanical dewatering to prepare impoundment materials for off-site beneficial reuse or thermal treatment at a cement kiln or incinerator. The bench-scale study was completed in accordance with the *Mechanical Dewatering Bench-Scale Testing Work Plan* approved by the U.S. Environmental Protection Agency (USEPA) on January 13, 2016. Conditional approval from USEPA was given on December 10, 2015 related to sample collection.

The bench-scale testing was designed to provide information to support the development of a remedial alternative involving dewatering of the impoundment material to allow off-site beneficial reuse or thermal treatment. The objectives of the mechanical bench-scale dewatering trial were the following:

- Collect samples for mechanical dewatering bench-scale testing (summarized in this report)
- Collect samples for thermally enhanced in-situ stabilization (ISS) bench-scale testing (ISS bench-scale testing summarized in a separate report)
- Evaluate dewatering potential of impoundment material, including viscous rubbery (VR) and hard crumbly (HC) impoundment tar material
- Evaluate potential for shipment of dewatered material as a solid
- Evaluate options for off-site beneficial reuse or thermal treatment of the dewatered material

This memorandum summarizes the following:

- Sample Collection
- Dewatering and Material Handling Tests
  - » Screening Tests
  - » Dewatering for Outlets

- » Mixing and Material Handling Tests
- » Viscosity Tests

- Results and Conclusions
- Evaluation of Beneficial Reuse and Treatment Outlets

SAMPLE COLLECTION

Sample collection was performed from January 4, 2016 to January 8, 2016. Aqua Survey, Inc. (ASI) was subcontracted to support sample collection. ASI had previously conducted similar sample collection activities on Impoundments 1 and 2 in 2010 and again in 2012. ASI deployed a sampling platform vessel with an A-frame to Impoundment 2. ASI used a high powered electro-vibracoring unit with a 4-inch steel barrel and a polyethylene bag liner to collect the sediment cores.

Sample Collection

ASI collected continuous samples to approximately 6 feet below the liner before refusal. Sample locations were recorded using a Global Positioning System (GPS). The sample location proposed in the Work Plan was modified because of low recoveries of VR material at that location. To recover a greater percentage of VR material, the vibracore was not pushed to refusal. Rather it was pushed a few feet and then re-inserted. Forty-one core samples were collected. Sample locations are shown on ***Figure 1***.

A trailer was staged onsite for core processing as depicted on ***Figure 1***. Cores were brought to the core processing area and material was separated into three categories: primarily VR, primarily HC, and VR/HC mix (interface layer). Cores were logged prior to transferring to 5-gallon buckets, and core logs are included in ***Table 1***. Seventeen buckets of material were collected and transported to O'Brien & Gere's (OBG's) Applied Technology Development Laboratory, located in Liverpool, New York, to perform the bench-scale dewatering tests. The container log is provided as ***Table 2***.

Core samples collected on January 6 and January 7, 2016 were used in a thermally enhanced ISS bench-scale testing study (conducted by others). Approximately twenty gallons of material was collected, including two 5-gallon buckets of primarily VR material and two 5-gallon buckets of primarily HC material. There was additional VR/HC mix (interface) material that was not needed for the thermally enhanced ISS bench-scale study, and this material was provided to OBG as noted in ***Table 2***.

Air monitoring was conducted on the vessel and at the core processing area with a photoionization detector (PID) and a hydrogen sulfide meter. Downwind air monitoring of the sample collection was completed in accordance with the Work Plan.

DEWATERING AND MATERIAL HANDLING TESTS

Dewatering potential via mechanical shearing of the material from the 17 buckets was evaluated on the bench-scale. Testing was performed in OBG's Applied Technology Development Laboratory in Liverpool, New York. Mechanical shearing was evaluated by processing samples through a single-screw meat grinder with an extrusion plate and extrusion tube. The intent was to dewater VR, HC, and VR/HC mix (interface layer) material separately. In order to optimize dewatering and handling of raw VR and HC following initial screening, the two materials were mixed at various ratios to evaluate changes in material handling and dewatering efficiency. Dewatering was evaluated by comparing moisture content of raw and dewatered samples, as analyzed by the Karl Fischer method as specified in the approved Work Plan.

The goals of the dewatering tests were to achieve dewatered material that passes paint filter test and with a moisture content less than 30%.

The dewatering and material handling tests included the following efforts:

- Screening Tests,
- Dewatering for Outlets,
- Mixing and Material Handling Tests,
- Viscosity Testing.

Equipment for Bench-Scale Mechanical Dewatering Tests

The test matrices are included as ***Table 3, Table 4*** and ***Table 5***. The test nomenclature includes the bucket that material was utilized from and the test number (e.g., HC1-Test1 used material from bucket HC1).

SCREENING TESTS

Screening tests used 6 to 7 pounds (lbs) of material. To perform screening tests, the weight of raw material fed to the equipment was recorded. Raw material was fed to the equipment, and dewatered material from the discharge was collected and weighed. The dewatering equipment discharge included a stainless steel knife, extrusion plate, and 1-1/8" diameter extrusion tube. This configuration was noted as "D1". All dewatering tests utilized this discharge, except for initial screening of VR. During the first screening test of VR, three discharge configurations were used:

- D1 – Stainless steel knife, extrusion plate, 1-1/8" diameter extrusion tube.
- D2 – Stainless steel knife, 3/8" plate.
- D3 – Stainless steel knife, 3/16" plate.

The data indicated that the D1 discharge configuration resulted in the lowest moisture content, and the data from the D1 configuration is included in ***Table 3***.

The weight and volume of separated Aqueous Phase was recorded, and the weight of residual material defined as material that remains in the equipment following testing was recorded. With these weight data, and accounting for any samples collected during testing, a test recovery (e.g., mass balance) was calculated. Complete recovery would result in 100%. Recoveries from screening tests were generally >90%. Refer to ***Table 3*** for additional information. Moisture content of raw and dewatered material were evaluated for each test by SGS Accutest, located in Dayton, New Jersey, and these data are also presented in ***Table 3***.

Screening tests were performed using material at room temperature (62 degrees Fahrenheit [°F] to 67 °F) and refrigerated material (46 °F to 51 °F).

DEWATERING FOR OUTLETS

Once it was determined that dewatering the material was feasible, three potential outlets requested representative samples of material for evaluation to develop preliminary acceptance rates. Table 1-1 below summarizes the sample requests.

Table 1-1. Summary of Sample Requests from Potential Outlets

Outlet Name	Location	Type	VR	HC	VR/HC Mix (Interface)
Outlet 1	Midwest US	Cement Kiln	2 gallons (raw)	2 gallons (dewatered)	2 gallons (dewatered)
Outlet 2	Midwest US	Cement Kiln	1 quart (raw)	1 quart (dewatered)	1 quart (dewatered)
Outlet 3	Midwest US	Incinerator	2 gallons (raw)	2 gallons (dewatered)	2 gallons (dewatered)

Each 2-gallon sample of dewatered material was generated as a single dewatering test. Similar to the Screening trials, weights of material fed and collected from the equipment were recorded to develop a test recovery percentage. Two raw and two dewatered samples were collected for moisture analysis from each as well as one dewatered sample analysis of flash point.

Raw VR material was provided to potential outlets. The moisture content of raw VR (<15%) suggests that VR may be shipped in the raw form, but may require some surface absorbents to manage potential free liquid.

Data collected from the dewatered material for Potential Outlet evaluation are included as ***Table 4***.

Shaker Testing

Shaker testing was utilized to evaluate the release of free liquid. One gallon of dewatered material from each Dewatering for Outlets test was added to a paint can and shook (via a paint can shaker) for 5 minutes and 15 minutes. The presence of free liquid after 5 minutes and 15 minutes was recorded and defined as *Pass* or *Fail*, as noted on ***Table 4***.

Paint Filter Testing

Paint Filter Testing

Paint filter testing was performed to confirm whether the dewatered material may be classified as a solid. Paint filter testing was performed by OBG utilizing dewatered material from each of the two-gallon buckets generated during the Dewatering for Outlets tests. Additionally, one sample from each two-gallon bucket was analyzed for moisture content by SGS Accutest.

HC AND VR MIXING TESTS

The objective of the mixing tests were to evaluate if HC and VR could be mixed together or if they remain separate, and to determine the resulting properties of the mixes.

Mixing of HC and VR and Evaluation of Properties

HC and VR material were mixed together by hand to evaluate how well the material mixed together and subsequent material handling properties. Three mixing tests were conducted at different mix ratios as indicated in the table below. The target weight of material in each test is also provided.

Table 1-2. Summary of HC and VR Mixing Tests

	HC	VR	HC (lbs)	VR (lbs)	HC/VR Test Mix (lbs)
Test 1	50%	50%	12	12	24
Test 2	25%	75%	8	16	24
Test 3	75%	25%	16	8	24

Material was transferred from their 5-gallon raw sample buckets to plastic-lined 15 quart totes for weighing. Material from raw buckets HC4, HC5, VR3, and VR4 were used (refer to ***Table 2*** and ***Table 5***). Once weighed, material was combined to a single tote and mixed by hand for approximately 5 minutes. Material properties of the resulting mixes were evaluated as described below. The material properties of raw HC, raw VR, and raw VR/HC Mix (interface) material were also evaluated for comparison. The objective of the mix tests was to evaluate how similar mixes of VR and HC (Tests 1 – 3 above) compare to field-collected interface material and raw material.

Material property observations included:

- Compressibility – Material was squeezed by hand to observe the bulking quality of the material. The thumb penetration test (used for soil classification) was also utilized.
- Plasticity – A sample was molded into a ball and attempted to be rolled into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. This procedure is used for soil classification (Atterberg limits test).
- Unconfined Compressive Strength – A pocket penetrometer was used to evaluate unconfined compressive strength. The penetrometer is a spring loaded device with a 1/4" diameter piston that is pushed a 1/4" into the material. For soft materials, a foot adapter is used that has a 1" diameter. The gauge is direct reading in tons per square foot or kilograms per square centimeter. Using the adapter foot requires the direct reading in tons per square foot (TSF) to be divided by 16 to account for the increased surface area.

Pocket Penetrometer

- Shear Strength – A pocket shear van tester was used to evaluate shear strength of cohesive solids. Readings can be made from 0 to 2.5 TSF.
- Granularity – Material was squeezed between thumb and index finger to evaluate granular size of the material.
- Tackiness – Visual observation of how well the material released from gloves and metal surfaces.

Pocket Shear Vane Tester

Flowability and Tackiness

Flowability was evaluated by allowing the material to sit overnight in a plastic-lined tote. The tote was tipped to an approximate 90 degree angle and the discharge of the material was recorded by video. This test was intended to simulate discharge of the material from a dump trailer. Following discharge of the material from the tote, the material was separated from the plastic to further evaluate tackiness as it relates to off-site handling. Visual observations were made during the separation process.

Raw HC, VR, and Interface material were evaluated for comparison, as well as the three dewatered Mix tests (Tests 1-3).

Viscosity

Viscosity testing was performed using a Brookfield Engineering Laboratories viscometer (model DV2THA). Testing was evaluated from approximately 32 °F to 100 °F in 10 °F increments. Viscosities for raw HC, raw VR, raw interface, and raw Mix Test 2 (25% HC/75% VR) were evaluated. The viscosity of dewatered Mixt Test 3 (75% HC/25% VR) was also evaluated.

Viscosity data are presented as ***Figure 2***.

Dewatering of Mixed Material

Mixed material generated from the mixing tests (Tests 1-3) was dewatered in the same manner as the dewatering for outlet tests. Material from each mixing test (approximately 24 lbs) was dewatered as one dewatering test. Dewatered material was collected in a plastic-lined tote and then transferred to a 2.5 gallon bucket suitable for shipment to outlets if requested.

Raw and dewatered moisture content were evaluated twice for each test and is included in ***Table 3***.

RESULTS AND CONCLUSIONS

HC, VR, and mixed material can be effectively dewatered via standard mechanical methods to produce a material suitable for offsite shipment and acceptance at offsite beneficial reuse or treatment outlets. Results are presented in ***Table 3***, ***Table 4*** and ***Table 5***. A discussion of the results and conclusions from the dewatering and material handling tests are presented below.

HARD AND CRUMBLY (HC)

HC was successfully dewatered and the moisture content of the dewatered material ranged from 3.7% to 8.1%. The dewatered material passed paint filter. During dewatering, a 20°F to 30°F temperature rise was observed. The average aqueous phase removal was 23% of the starting weight of raw material. Raw HC material formed a monolithic block during storage in the sample bucket and was difficult to remove from the bucket. Removal required fracture of the material into smaller pieces by hand and with the use of a trowel. Raw HC crumbled when worked by hand and did not exhibit plasticity.

When refrigerated, raw HC exhibited a lower moisture content than raw HC at room temperature. The lower moisture content in refrigerated material is supported by the reduced amount of aqueous phase removed during dewatering. These data may indicate that raw HC at low temperatures has less propensity to retain free liquid. The viscosity of raw HC decreased with increasing temperature, and the effects of temperature on viscosity was greater below 60 °F.

VISCOUS RUBBERY (VR)

VR was successfully dewatered and the moisture content of dewatered material ranged from 2% to 4%. The average aqueous phase removal was 3% of the starting weight. The mechanical clearances of the bench-scale equipment were not tight enough to continually force VR through the system and would frequently clog the meat grinder. However, the bench-scale dewatering equipment would continue to spin and there was no appreciable temperature rise in the material from dewatering. This indicates that the material behaved more like an oil.

Raw VR material resembled a heavy sludge, was tacky, and left a residue on plastic and metal surfaces. The moisture content of raw VR ranged from 7.2% to 14.3%, and is below the 15% target provided by some offsite outlets. Raw VR was provided to outlets for evaluation. Raw VR did not pass paint filter, however, the raw moisture content is low and it may be feasible to remove any free liquid with the use of absorbents. Additional evaluation of shipping raw VR with absorbents to manage free liquid may be required.

Refrigerated raw VR was not dewatered. Viscosity testing indicated minimal change in viscosity between 32 °F and 100 °F.

MIX MATERIAL

VR/HC Interface

Field collected VR/HC Mix or interface material was successfully dewatered and the moisture content of the dewatered material ranged from 2.2% to 11.6%. The dewatered material passed paint filter. During dewatering, a 10°F to 20°F temperature rise was observed. The average aqueous phase removal was 15% of the starting raw weight. Raw mix material generally exhibited properties similar to HC. The material was easier to remove from the bucket than HC.

When refrigerated, raw VR/HC interface material exhibited a lower moisture content than raw VR/HC interface material at room temperature. The lower moisture content in refrigerated material is supported by the reduced amount of aqueous phase removed during dewatering. These data may indicate that raw VR/HC interface material at low temperatures has less propensity to retain free liquid. The viscosity of raw VR/HC interface material (indicated as "MIX Raw" on ***Figure 2***) decreased with increasing temperature, and the effects of temperature on viscosity were generally linear.

VR and HC Mix Tests

VR and HC mixes (mixed in the laboratory) were observed to handle easier than either raw HC or raw VR. A percentage of HC greater than or equal to 50% (Mix Tests 1 and 3) reduced the temperature rise from dewatering, and improved the speed at which material was fed to the equipment. The mix ratio of 75%VR/25%HC (Mix Test 2) improved dewatering as compared to raw VR, but still resulted in periodic clogging of the machine. Dewatered material from each of the three mix tests passed paint filter.

The viscosity of raw mixed material (indicated as "MTest2 Raw" on ***Figure 2***) decreased with increasing temperature, and the effects of temperature on viscosity were generally linear. The viscosity of dewatered mix material (indicated as "MTest3 Dewatered" on ***Figure 2***) exhibited an exponential relationship to temperature with viscosity decreasing significantly with increasing temperature.

EVALUATION OF TREATMENT AND DISPOSAL OUTLETS

Three outlets requested and received material for evaluation as noted above. Each outlet indicated that they could accept the material. Specific waste acceptance criteria, limitations, and material handling capabilities were obtained from each, and a summary is provided in the table below.

Table 1-3. Summary of Waste Acceptance Criteria

Outlet Name	Type	Water Content	Heat Content	Sulfur Content
Outlet 1	Cement Kiln	<40%	>3,000 BTU	No Specified Limit (will affect feed rate)
Outlet 2	Cement Kiln	No Specified Limit (will affect feed rate)	>5,000 BTU	No Specified Limit (will affect feed rate)
Outlet 3	Incinerator	No Specified Limit	No Specified Limit (will affect feed rate)	<10% (or surcharges apply)

In addition to water, heat, and sulfur content, the outlets have provided limits for heavy metals and debris content. Each outlet is currently permitted to receive waste under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Each facility has also confirmed that their RCRA permit allows them to process materials carrying D018 (benzene), D027 (1,4-dichlorobenzene) and D036 (nitrobenzene) codes. Average acceptance rates range from 130 to 315 tons per week.

TABLES

Table 1 - Sample Collection - Core Log

Core No.	Date	Time	GPS Coordinates N	GPS Coordinates E	VR (Viscous Rubbery)	VR/HC Mix (Interface)	(Hard and Crumbly)
1	1/4/16	1251	626612.8	2032370.1	0 to 1.5'	1.5' to 3'	3' to 3'10"
2	1/4/16	1350	626631.2	2032358.2	0 to 1'1"	1'1" to 2'5"	2'5" to 4'7"
3	1/4/16	1402	626628.8	2032358.4	0 to 1'6"	1'6" to 2'6"	2'6" to 4'
4	1/4/16	1415	626624.3	2032357.9	0 to 9"	9" to 2'2"	2'2" to 4'10"
5	1/5/16	0929	626627.7	2032360.3	0 to 1'	1' to 3'	3' to 4'7"
6	1/5/16	1034	626622	2032368.3	0 to 9"	9" to 1'10"	1'10" to 3'4"
7	1/5/16	1124	626622.5	2032364.6	0 to 1"	1" to 1'10"	1'10" to 3'10"
8	1/5/16	1140	626628.8	2032366	0 to 1'2"	1'2" to 2'1"	2'1" to 3'7"
9	1/5/16	1203	626626.5	2032360	0 to 9"	9" to 2'2"	2'2" to 3'9"
10	1/5/16	1343	626629.3	2032361.6	0 to 9"	9" to 2'11"	2'11" to 4'
11	1/5/16	1404	626626.5	2032365.1	0 to 1'	1' to 2'	2' to 4'
12	1/5/16	1427	626630	2032364.1	0 to 1'	1' to 2'	2' to 4'
13	1/5/16	1444	626627.8	2032359.4	0 to 9"	9" to 2'	2' to 3'10"
14	1/5/16	1455	626627.5	2032353.2	0 to 10"	10" to 1'6"	1'6" to 4'
15	1/6/16	1002	626749.5	2032406	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
16	1/6/16	1021	626746.8	2032407	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
17	1/6/16	1049	626751.3	2032402.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
18	1/6/16	1107	626755.3	2032407.3	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
19	1/6/16	1122	626754.3	2032403.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
20	1/6/16	1332	626706.7	2032516	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
21	1/6/16	1351	626725.7	2032476.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
22	1/6/16	1444	626752.2	2032405.6	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
23	1/6/16	1512	626753.9	2032399.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
24	1/7/16	1014	626678.4	2032554.2	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
25	1/7/16	1029	626678.4	2032554.2	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
26	1/7/16	1051	626673.4	2032560.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
27	1/7/16	1106	626673.4	2032560.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
28	1/7/16	1315	626676	2032558.5	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
29	1/7/16	1332	626678.2	2032558.1	Core provided for Thermally Enhanced ISS Bench-Scale Testing		

Table 1 - Sample Collection - Core Log

Core No.	Date	Time	GPS Coordinates N	GPS Coordinates E	VR (Viscous Rubbery)	VR/HC Mix (Interface)	(Hard and Crumbly)
30	1/7/16	1338	626677.2	2032556	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
31	1/7/16	1353	626677.2	2032556	Core provided for Thermally Enhanced ISS Bench-Scale Testing		
32	1/7/16	1448	626671.6	2032558.3	0 to 1'3" 1'10" to 2'6" 3' to 3'6" 4' to 5'6"	1'3" to 1'10" 2'6" to 3'	3'6" to 4'
33	1/7/16	1505	626673.3	2032558.2	0 to 1' 1'6" to 2' 2'6" to 3' 3'6" to 3'9" 4'6" to 5' 5'9" to 7'	1' to 1'6" 2' to 2'6" 3' to 3'6" 5'3" to 5'6"	3'9" to 4'6" 5'6" to 5'9"
34	1/8/16	0852	626674.1	2032554.8	0 to 4'6" (Some interface mixed in)	5' to 5'6"	4'6" to 5'
35	1/8/16	0909	626674.6	2032557.3	0 to 1' 1'6" to 2'3" 3' to 3'9"	1' to 1'6" 2'3" to 2'6"	2'6" to 3' 4' to 5'6"
36	1/8/16	0925	626674.7	2032553.3	0 to 1'	1' to 3'6"	3'6" to 5'
37	1/8/16	0941	626675.4	2032554.5	0 to 1' 2' to 2'4" 2'9" to 4'6"	1' to 2' 2'4" to 2'9" 4'6" to 5'6"	
38	1/8/16	1151	626675.9	2032557.4	0 to 1' 1'6" to 2'6" 3' to 3'6" 4'6" to 5'	3'6" to 4'6" 5' to 5'3"	1' to 1'6" 2'6" to 3'

Table 1 - Sample Collection - Core Log

Core No.	Date	Time	GPS Coordinates N	GPS Coordinates E	VR (Viscous Rubbery)	VR/HC Mix (Interface)	(Hard and Crumbly)
39	1/8/16	1205	626675.4	2032557.1	0 to 1'3" 1'6" to 2' 3' to 3'6" 4' to 4'6" 5' to 5'6"		1'3" to 1'6" 2' to 3' 3'6" to 4' 4'6" to 5' 5'6" to 6'
40	1/8/16	1220	626680.9	2032557.4	0 to 1' 1'6" to 2'6"	1' to 1'6"	2'6" to 4'6"
41	1/8/16	1235	626680.1	2032557	0 to 1' 1'6" to 4'	4' to 5'6"	1' to 1'6"

Notes:
[1] - GPS coordinatates are in NJ State Plane NAD 83 in survey feet.

Table 2 - Sample Collection - Container Log

Container ID	Material Notes
Viscous Rubbery (VR)	
OBG-160105-I2VR1	Material from cores 1 through 14.
OBG-160108-I2VR2	Material from cores 32 through 34.
OBG-160108-I2VR3	Material from cores 35 through 38
OBG-160108-I2VR4	Material from cores 39 through 41.
Hard and Crumbly (HC)	
OBG-160104-I2HC1	Material from cores 1 through 4.
OBG-160105-I2HC2	Material from cores 5 through 9.
OBG-160105-I2HC3	Material from cores 10 through 14.
OBG-160108-I2HC4	Material from cores 32 through 38.
OBG-160108-I2HC5	Material from cores 39 through 41.
VR/HC Mix (Interface)	
OBG-160104-I2MX1	Material from cores 1 through 7.
OBG-160105-I2MX2	Material from cores 8 through 14.
OBG-160105-I2MX3	Extra not needed for Thermally Enhanced ISS Bench-Scale Study
OBG-160105-I2MX4	Extra not needed for Thermally Enhanced ISS Bench-Scale Study
OBG-160108-I2MX5	Extra not needed for Thermally Enhanced ISS Bench-Scale Study
OBG-160108-I2MX6	Material from Boat (vibracore head)
OBG-160108-I2MX7	Material from cores 32 through 38.
OBG-160108-I2MX8	Material from cores 39 through 41.

				RAW MATERIAL		DEWATERED MATERIAL				
Test ID	Test Date	Bucket ID	Temperature	Raw Weight (lbs)	Raw Moisture Content (%)[1]	Dewatered Weight (lbs)	Dewatered Temperature	Dewatered Moisture Content (%) [1]	Aqueous Phase Removed (% by Wt)	Test Mass Recovery
MIX MATERIAL										
VR/HC Mix (Interface)										
Screening Tests										
Mix1-Test1	1/13/2016	OBG-160104-I2MX1	Room Temp	6.09	**33.5**	3.89	Not Tested	**4.6**	18%	94%
Mix1-Test2	1/13/2016	OBG-160104-I2MX1	Room Temp	6.61	**26.1**	2.96	Not Tested	**8.5**	16%	90%
Mix1-Test3	1/13/2016	OBG-160104-I2MX1	Room Temp	6.52	**23.7**	3.71	Not Tested	**11.6**	27%	93%
Mix1-Test4	1/14/2016	OBG-160104-I2MX1	62 deg F	7.3	**15.5**	2.83	72 deg F	**5.5**	21%	90%
Mix5-Test5	2/10/2016	OBG-160108-I2MX5	46 deg F	6.06	**6.6**	5.11	62 to 68 deg F	**6.3**	4%	95%
Mix5-Test6	2/10/2016	OBG-160108-I2MX5	51 deg F	6.74	**8.2**	4.99	61 to 66 deg F	**5.3**	9%	96%
Dewatering for Outlets										
Mix2-Btest1 (For Outlet 1)	2/10/2016	OBG-160105-I2MX2	61 deg F	29.18	**6.8** **20.2**	18.38	72 to 82 deg F	**4.3** **4**	18%	96%
Mix7-Btest2 (For Outlet 3)	2/10/2016	OBG-160108-I2MX7	63 deg F	36.38	**8.6** **3.5**	30.53	64 to 70 deg F	**3.9** **2.2**	7%	96%
Mixed Material from VR/HC Mixing Tests										
MTest 1 (50%HC/50%VR)	3/29/2016	MTest1	56 deg F	23.1	**2.8** **5.3**	19.61	63 to 65 deg F	**9.9** **3.5**	8%	94%
MTest 2 (25%HC/75%VR)	3/29/2016	MTest2	57 deg F	23.5	**6.6** **5.7**	11.36	63 deg F	**3.9** **4.5**	3%	78%
MTest 3 (75%HC/25%VR)	3/29/2016	MTest3	57 deg F	22.2	**13.2** **9.9**	18.42	67 deg F	**7.1** **10.9**	10%	95%
HC MATERIAL										
Screening Tests										
HC1-Test1	1/13/2016	OBG-160104-I2HC1	Room Temp	7.94	**23.9**	2.59	Not Tested	**6.6**	29%	96%
HC1-Test2	1/14/2016	OBG-160104-I2HC1	62 to 65 deg F	7.44	**7.3**	3.05	80 to 100 deg F	**8.1**	24%	87%
HC1-Test3	2/9/2016	OBG-160104-I2HC1	57 deg F	6.11	**18.5**	3.08	67 to 73 deg F	**3.9**	24%	93%
HC1-Test4	2/9/2016	OBG-160104-I2HC1	60 deg F	5.98	**7.3**	2.02	66 to 77 deg F	**4.4**	28%	92%
HC4-Test5	2/9/2016	OBG-160108-I2HC4	49 deg F	6.24	**16.4**	4.87	66 to 70 deg F	**4.6**	12%	96%
HC4-Test6	2/9/2016	OBG-160108-I2HC4	47 deg F	6.91	**3.3**	5.58	65 deg F	**4.4**	6%	92%
Dewatering for Outlets										
HC2-Btest1 (For Outlet 1)	2/10/2016	OBG-160105-I2HC2	64 deg F	33.12	**16** **10.3**	16.94	83 to 102 deg F	**4.1** **6.6**	31%	93%
HC3-Btest2 (For Outlet 3)	2/11/2016	OBG-160105-I2HC3	62 deg F	33.86	**13.6** **11.9**	14.92	79 to 93 deg F	**6.8** **3.7**	26%	91%
VR MATERIAL										
Screening Tests										
VR3-Test1	1/13/2016	OBG-160108-I2VR3	Room Temp	6.87	**12.7**	4.02	Not Tested	**3.4**	Intermixed Residual	95%
VR3-Test2	2/10/2016	OBG-160108-I2VR3	67 deg F	7.14	**8.5**	5.38	67 deg F	**9.6**	2%	86%
VR3-Test3	2/10/2016	OBG-160108-I2VR3	67 deg F	6.28	**7.2**	2.85	67 deg F	**4.2**	4%	103%
VR3-Test4	*Test Not Conducted[2]*									
VR3-Test5	*Test Not Conducted[2]*									
VR3-Test6	*Test Not Conducted[2]*									
Dewatering for Outlets										
VR1-Btest1 (For Outlet 1)	2/11/2016	OBG-160105-I2VR1	65 deg F	Not Weighed (filled bucket)	**11.7** **11.5**	NA	NA	NA	NA	NA
VR2-Btest2 (For Outlet 3)	2/11/2016	OBG-160108-I2VR2	60 deg F	Not Weighed (filled bucket)	**9.6** **14.3**	NA	NA	NA	NA	NA

Legend:
HC - Hard and Crumbly material
VR - Viscous Rubbery material
MIX - Interface layer of HC and VR
NA - Not applicable

Notes:
[1] - Moisture content is based on wet basis.
[2] - Additional tests were not conducted as the equipment used was identified to not have tight enough mechanical clearances to force the material out of the grinder

TABLE 4 | DEWATERED MATERIAL FOR OUTLETS EVALUATION

Test ID	Test Date	Bucket ID	Dewatered Moisture Content (%) [1]	Flash Point (deg F)	Shaker Test	Paint Filter (ml/100g)
MIX MATERIAL						
VR/HC Mix (Interface)						
Dewatering for Outlets						
Mix2-Btest1 (For Outlet 1)	2/10/2016	OBG-160105-I2MX2	**4.3**	69.2	Pass	2 by OBG (Pass)
			4	72.2		<0.50
Mix7-Btest2 (For Outlet 3)	2/10/2016	OBG-160108-I2MX7	**3.9**	77.2	Pass	2 by OBG (Pass)
			2.2	70.2		<0.50
HC MATERIAL						
Dewatering for Outlets						
HC2-Btest1 (For Outlet 1)	2/10/2016	OBG-160105-I2HC2	**4.1**	71.5	Pass	2 by OBG (Pass)
			6.6	72.2		<0.50
HC3-Btest2 (For Outlet 3)	2/11/2016	OBG-160105-I2HC3	**6.8**	73.8	Pass	2 by OBG (Pass)
			3.7	72.2		<0.50
VR MATERIAL						
Dewatering for Outlets						
VR1-Btest1 (For Outlet 1)	2/11/2016	OBG-160105-I2VR1	NA	71.2	Fail (RAW)	*RAW* OBG (Fail)
				74.2		**3**
VR2-Btest2 (For Outlet 3)	2/11/2016	OBG-160108-I2VR2	NA	70.2	Fail (RAW)	*RAW* OBG (Fail)
				106		**7**

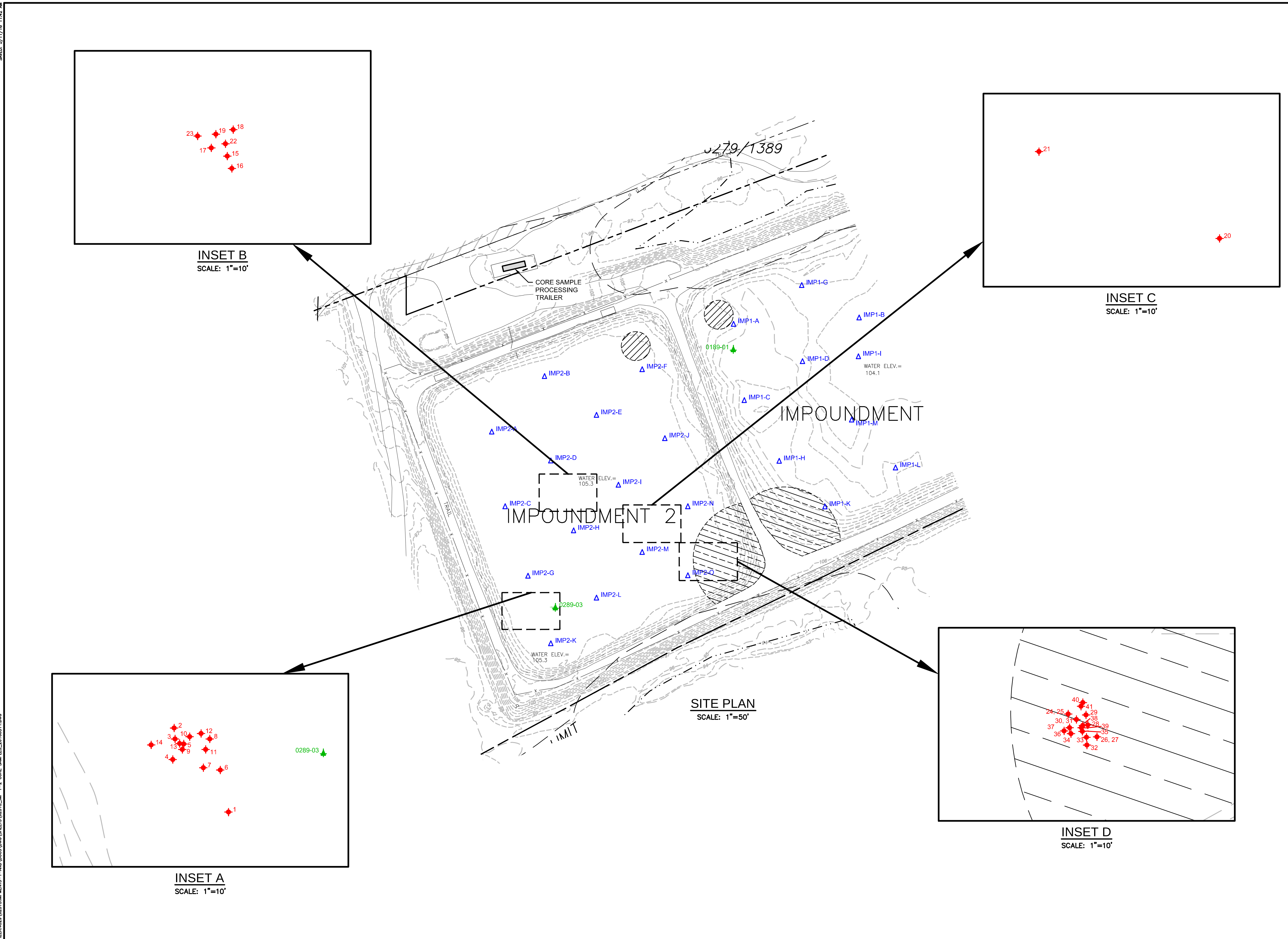
Legend:
HC - Hard and Crumbly material
VR - Viscous Rubbery material
MIX - Interface layer of HC and VR
NA - Not applicable

Notes:
[1] - Moisture content is based on wet basis.

Table 5 - HC and VR Mixing Tests - Test Matrix

Parameter	HC and VR Mixing Tests						Field Collected Raw Material		
	Test 1 (50%HC/50%VR)		Test 2 (25%HC/75%VR)		Test 3 (75%HC/25%VR)		HC	VR	VR/HC Mix (Interface)
	RAW	DEWATERED	RAW	DEWATERED	RAW	DEWATERED	RAW	RAW	RAW
Weight of Matieral									
Weight of Material(s) [Refer to Table 2 for container log]	12lbs HC5 12 lbs VR4	---	6 lbs HC5 18 lbs VR (13 lbs VR4, 5 lbs VR3)	---	18 lbs HC (3.5 lbs HC5, 14.5 lbs HC4) 6 lbs VR3	---	10 lbs HC4	18 lbs VR (2 lbs VR3, 16 lbs VR1)	13 lbs MIX8
Material Properties									
Compressibility	Thumb imprint, was able to release thumb	Thumb imprint, was able to release thumb	Thumb imprint, was able to release thumb	Thumb imprint, was able to release thumb	Crumbled apart during thumb imprint	Thumb imprint, was able to release	Thumb imprint, was able to release thumb, crumbled	Thumb imprint, able to form into a disc	Thumb imprint, was able to release thumb
Plasticity	1/2" to 1" threads	1/4" threads	1/4" to 1/2" threads	1/4" threads	Crumbled apart during test	1/4" to 1/2" threads	Material crumbles	1/2" to 3/4" threads	1/2" threads
Unconfined Compressive Strength (tons per square foot)	0.05	0.06	0.06	0.06	0.12	0.08	0.08	0.05	0.10
Shear Strength (tons per square foot)	1.6	3.8	2.4	6.0	2.8	4.0	4.4	2.6	3.4
Granularity	No determinable particle size, smeared like a paste	No determinable particle size, smeared like a paste	No determinable particle size, smeared like a paste	No determinable particle size, smeared like a paste	Spreads and crumbles, may have a fine grain particle	No determinable particle size	Spreads and crumbles	Spreads and breaks up	Spreads and breaks up
Tackiness	Released from gloves, but left residue	Released from gloves without leaving residue	Released from gloves, left some residue	Released from gloves leaving minimal residue	Released from gloves, left some particulate	Released from gloves leaving minimal residue	Released from gloves leaving minimal residue	Released from gloves, left some residue	Released from gloves, left some residue
Flowability and Tackiness									
Dump Test									
Observations	Dumped as fairly solid block, portions stuck to plastic, was able to be broken apart	Dumped as solid block, released from plastic, maintained shape when lifted	Dumped as solid block, portions stuck to plastic, did not break apart	Dumped as solid block, released from plastic, maintained shape when lifted	Dumped as solid block, released cleanly from plastic, was able to be broken apart	Dumped as solid block, released from plastic, maintained shape	Dumped as a fairly solid block, released cleanly from plastic, broke apart by hand	Dumped as a solid block, left some residue on plastic, some portions able to be broken apart	Dumped as a solid block, released cleanly from plastic, broke in half when folded
Viscosity									
Viscosity Range	Not tested	No tested	Refer to Figure 2	Not tested	Not tested	Refer to Figure 2	Refer to Figure 2	Refer to Figure 2	Refer to Figure 2
Dewatering of Mix Material									
Moisture Content	Refer to Table 3	Refer to Table 3	Refer to Table 3	Refer to Table 3	Refer to Table 3	Refer to Table 3	Not tested	Not tested	Not tested
Paint Filter (Dewatered)	Not tested	Pass	Fail	Pass	Not tested	Pass	Not tested	Not tested	Not tested

FIGURES



LEGEND

- PROPERTY LINE
- ELEVATION CONTOURS (5' INTERVALS)
- ELEVATION CONTOURS (1' INTERVALS)
- WETLANDS LIMIT
- EDGE OF WATER
- FENCE
- RAILROAD TRACKS
- APPROXIMATE GEO BORING LOCATIONS (2010)
- DISCREET HISTORICAL SAMPLING LOCATIONS (2010)
- APPROXIMATE LOCATION OF NON-DISCREET HISTORICAL SAMPLES (1995)
- APPROXIMATE LOCATION OF NON-DISCREET HISTORICAL SAMPLES (2000)
- 2016 CORE SAMPLE LOCATION

NOTE:
1. REFER TO TABLE 1 FOR CORE LOG.

WYETH HOLDINGS, LLC

IMPOUNDMENTS 1 & 2
MECHANICAL
DEW ATERING &
BENCH SCALE TESTING

2016
CORE SAMPLE
LOCATIONS

FIGURE 1

1"=50' 50 0 50

FILE NO. 4529.62515
MAY 2016

O'BRIEN & GERE ENGINEERS, INC.

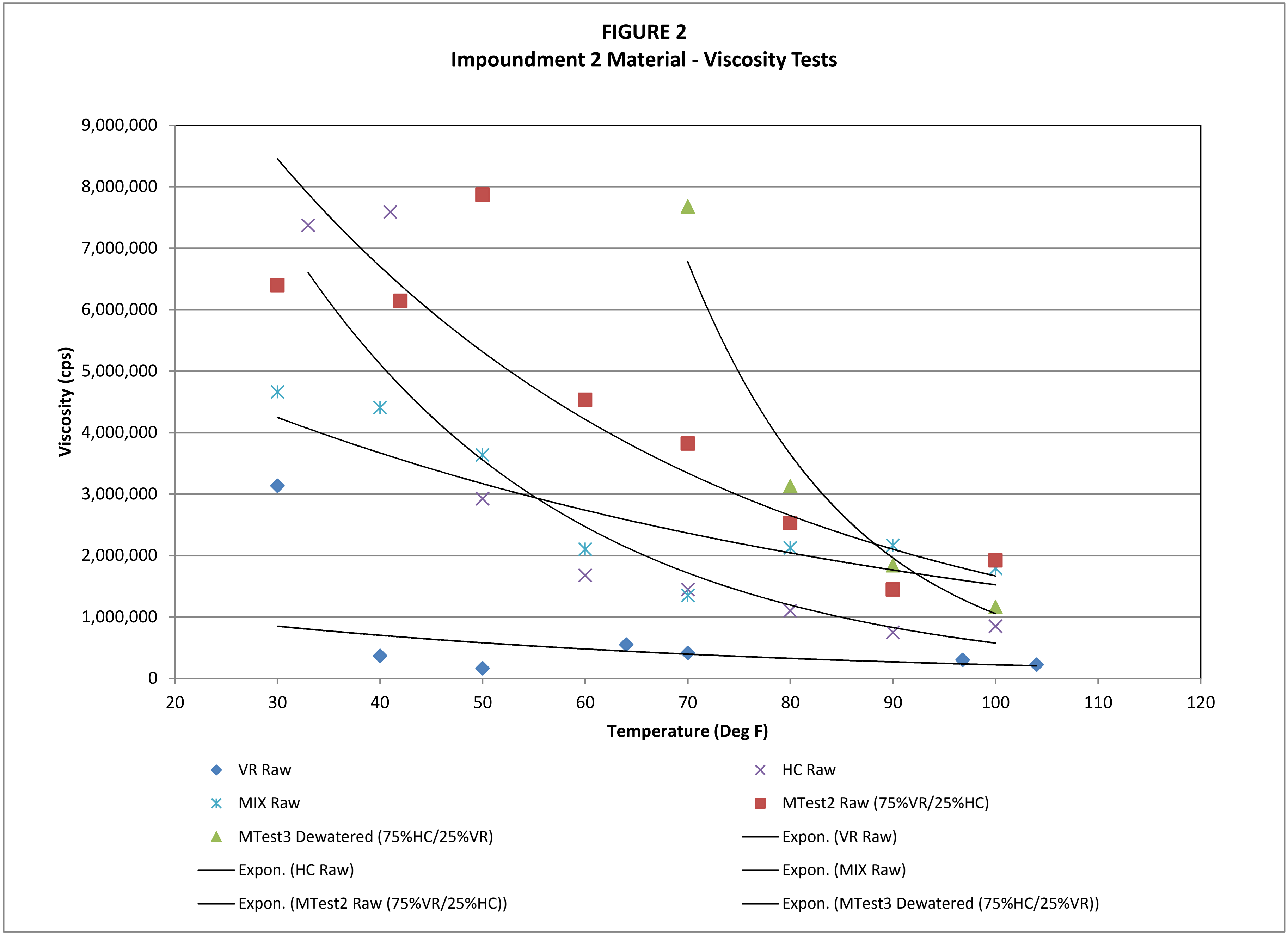


FIGURE 2
Impoundment 2 Material - Viscosity Tests
Viscosity (cps)
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
20
30
40
50
60
70
80
90
100
110
120
Temperature (Deg F)
VR Raw
HC Raw
MIX Raw
MTest2 Raw (75%VR/25%HC)
MTest3 Dewatered (75%HC/25%VR)
Expon. (VR Raw)
Expon. (HC Raw)
Expon. (MIX Raw)
Expon. (MTest2 Raw (75%VR/25%HC))
Expon. (MTest3 Dewatered (75%HC/25%VR))